Integrated Energy Systems: Technologies, Program Structure, and Applications

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Integrated Energy Systems (IES)

Peer Review Meeting

Nashville, Tennessee

April 30, 2002

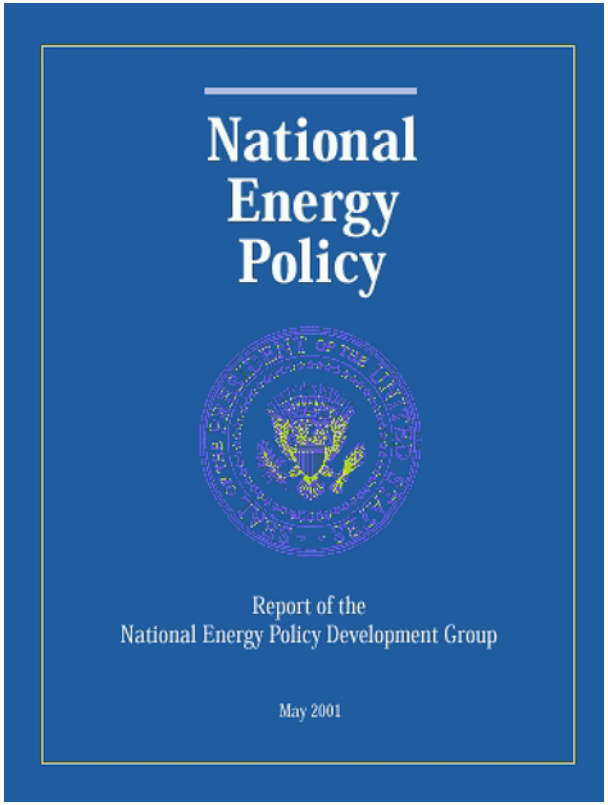
OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

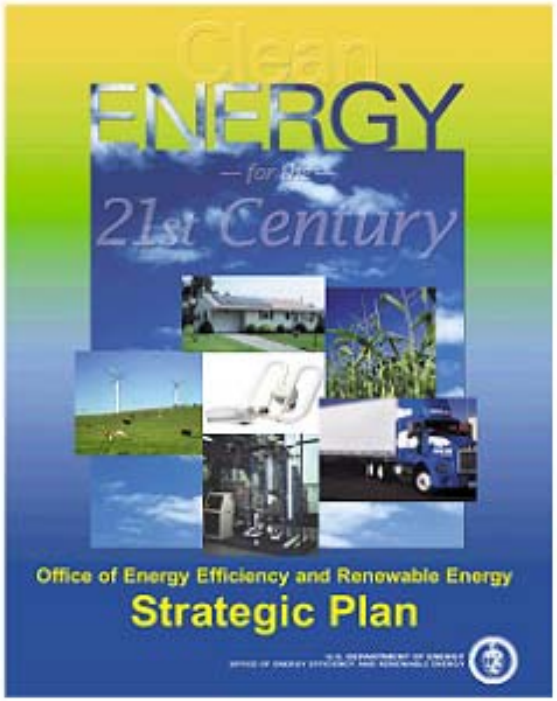
National Energy Policy

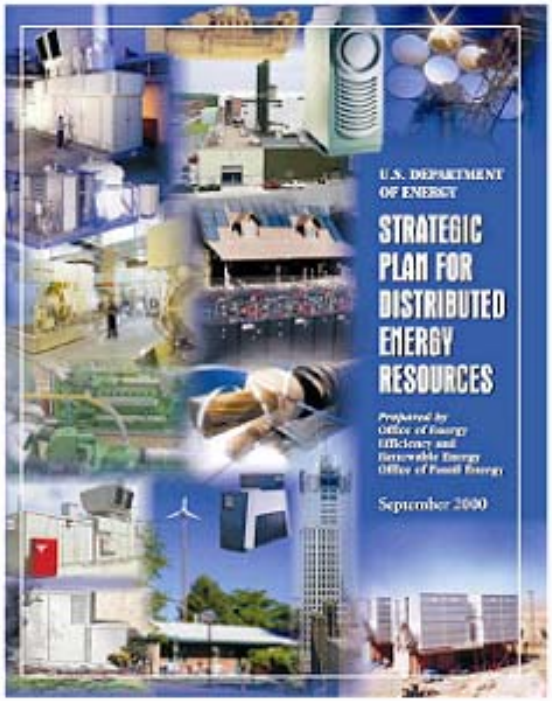
Of the 105 total recommendations…

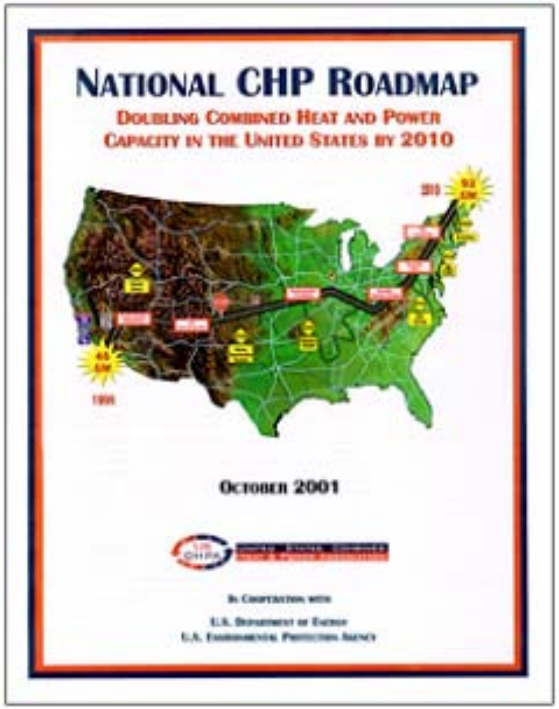
- 21 affect distributed energy
- 13 affect T&D
- 8 affect international activities
- 17 affect renewable energy



Integrated Energy Systems / Thermally Activated Technologies: Integral Part of DOE-DER-CHP Strategic Plans







Contributing to EERE/DER Goals

- **IES/TAT Program contributes to two of EERE's three major goals:**

Goal

Increase the supply and use of clean energy resources and increase the reliability of the energy systems.

Measurable Objectives & Benefits

- *By 2010, increase the amount of the nation's distributed power to 20% of new electricity capacity to mitigate transmission and distribution constraints by increasing U.S. on-site power generation capacity.*
- *By 2010, double the capacity of combined heat and power systems in the U.S. from the 1999 level to make use of thermal energy normally wasted in the generation of power.*

The CHP Goal and Roadmap

CHP and BCHP Roadmapping Events

Date	Event	Location
December 1, 1998	CHP Summit	Alexandria, VA
March 1, 1999	CHP Data Workshop	Washington, DC
March 11-12, 1999	CHP Initiative Founders Meeting	Chicago, IL
June 1-3, 1999	CCHP Roadmap Workshop	Chantilly, VA
June 8-9, 1999	CHP Vision Workshop	Washington, DC
June 28, 1999	CHP Analysis Workshop	Washington, DC
October 6, 1999	Combined Heat and Power – A New York Perspective	Albany, NY
November 8-9, 1999	BCHP Technology Program Planning Workshop	Chicago, IL
November 10-11, 1999	Lake Michigan Regional CHP Roadmap Workshop	Chicago, IL
January 12-13, 2000	BCHP Process Workshop	Washington, DC
January 19-20, 2000	Northeast Regional CHP Roadmap Workshop	Piscataway, NJ
February 1-2, 2000	International Symposium on Combined Heat and Power	Washington, DC
March 20-21, 2000	Pacific Northwest Regional CHP Challenge Workshop and Exposition	Seattle, WA
March 20-21, 2000	BCHP Policy Workshop	College Park, MD
April 6, 2000	Upper Northeast CHP Workshop	Orono, ME
May 16, 2000	New Mexico Summit on Combined Heat and Power	Albuquerque, NM
August 14-15, 2000	Texas CHP Workshop	Houston, TX
October 12-13, 2000	National CHP Roadmap Workshop	Baltimore, MD
October, 2001		Baltimore, MD

Program Portfolio

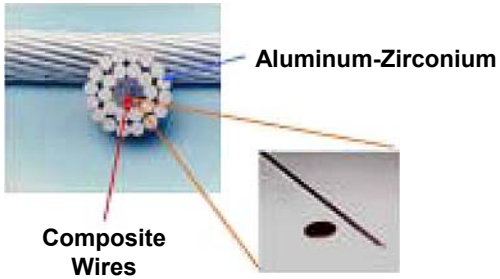
Fuel

Technology Development: Microturbines, reciprocating engines, fuel cells, materials, storage

Technology Packages: Integrated CHP systems, chillers desiccants

End-use Integration: Demand Management, controls, sensors

Composite Conductor



Electric and Gas Integration: Load management, sensitive loads, power electronics

Distribution Systems: Load management, power parks, microgrids, storage, ups, controls, DC grids

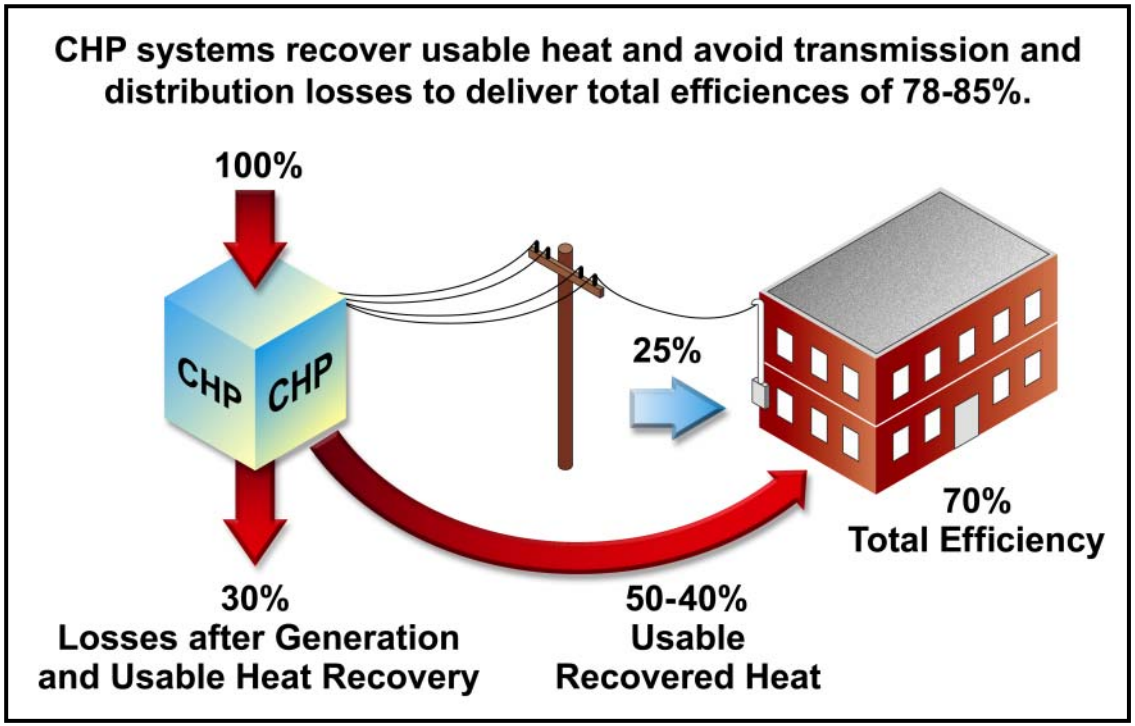
Transmission System: Wire materials, tools

IES Mission

The IES Mission is to perform the research, development and verification of a new class of distributed electric and thermal energy delivery systems for use at or near end-user sites.

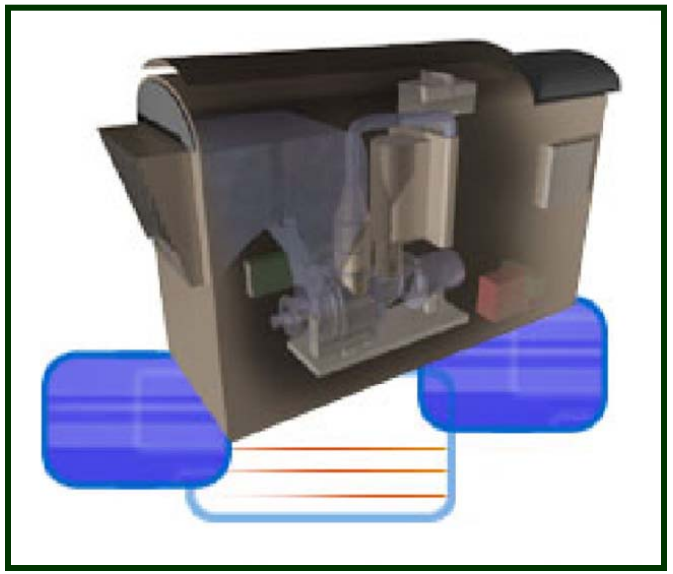
Distributed Energy-IES Benefits

- Increases systems efficiency
- Provides energy choice
- Reduces CO_2 emissions
- Conserves fuel resources
- Improves reliability
- Increases energy security
- Improves energy delivery utilization



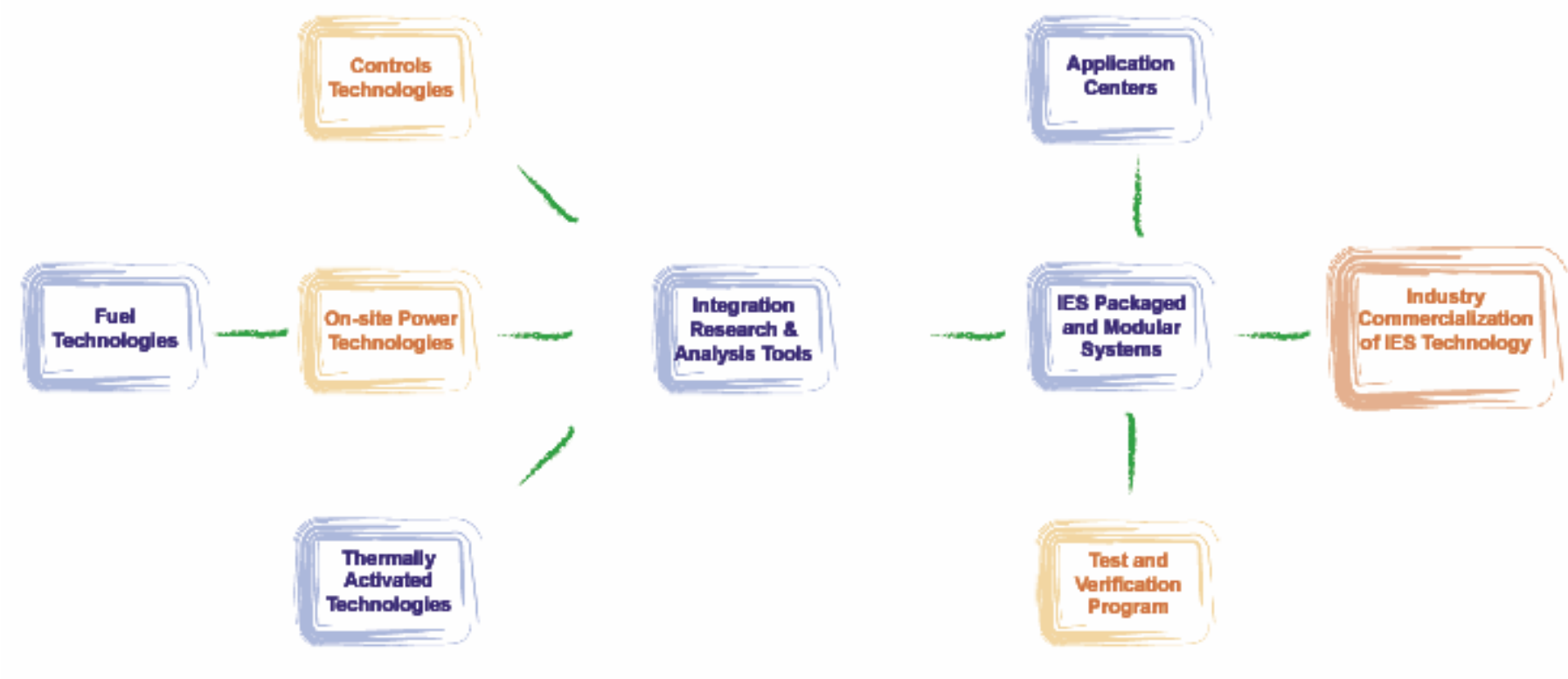
IES Vision
Packaged System Integration

2001: Individually optimized products combined on site



2010: IES – single optimized package from manufacturer

IES and TAT Program Elements



Thermally-Activated Technologies Are Key to Improving Overall Efficiency of DE

Thermally Activated Technologies

Distributed Generation Technologies

Thermally-Activated HVAC Technologies

800°F

600°F

360°F

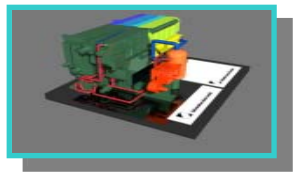
180°F

Gas-turbine

Solid Oxide Fuel Cell

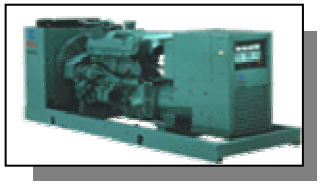
Microturbine

Commercial Phosphoric Acid Fuel Cell



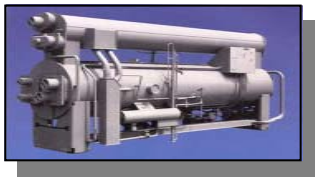
Triple-Effect Absorption Chiller

Double-Effect Absorption Water-Cooled Chiller



I.C. Engine

Residential PEM Fuel Cell

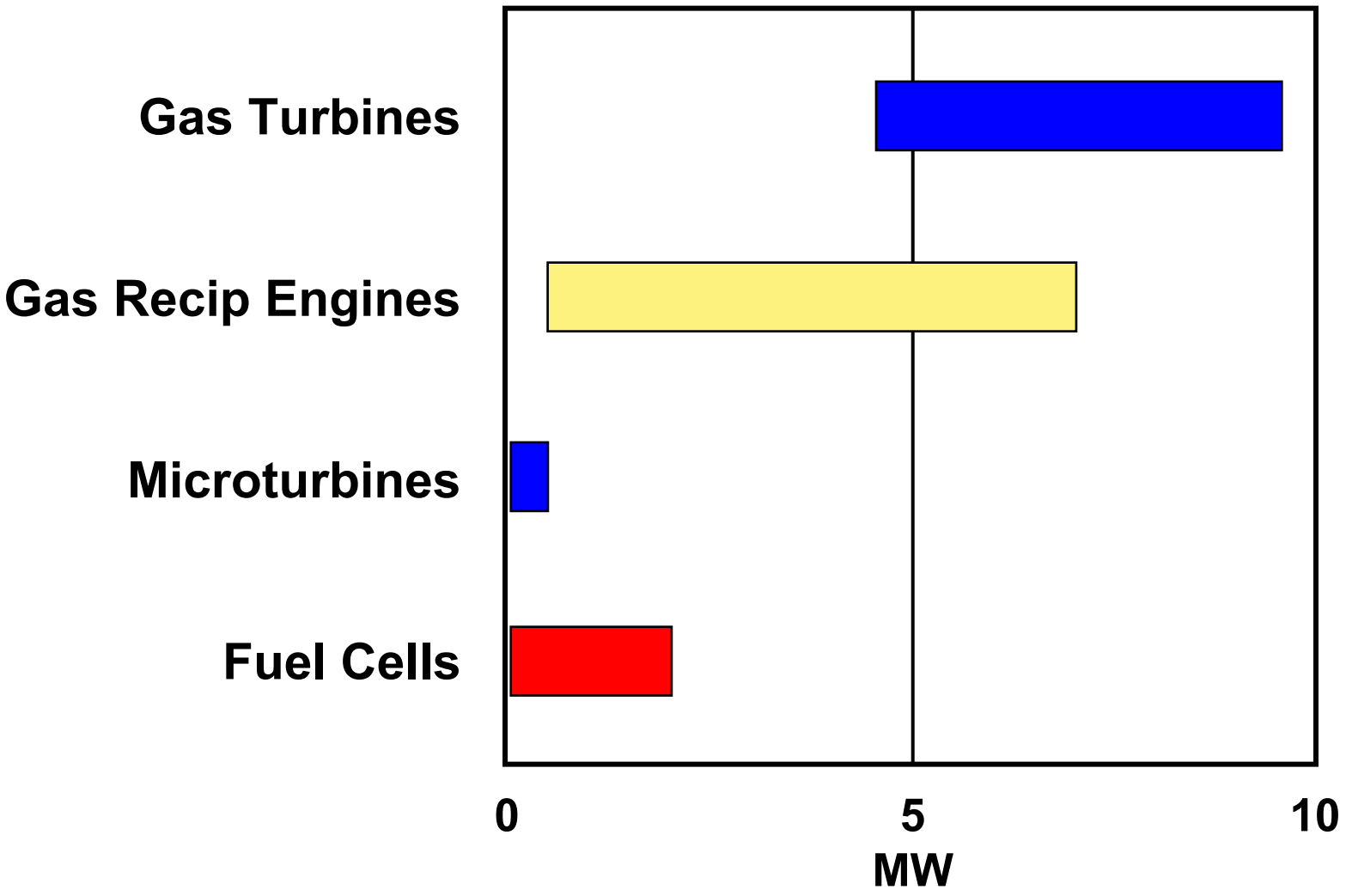


Single-Effect Absorption Chiller

Desiccant Technology

Recoverable Energy Quality (Temperature) and HVAC Technology Match

Primary DG Solutions



CHP Integration Laboratory at ORNL (part of DER Lab Network)

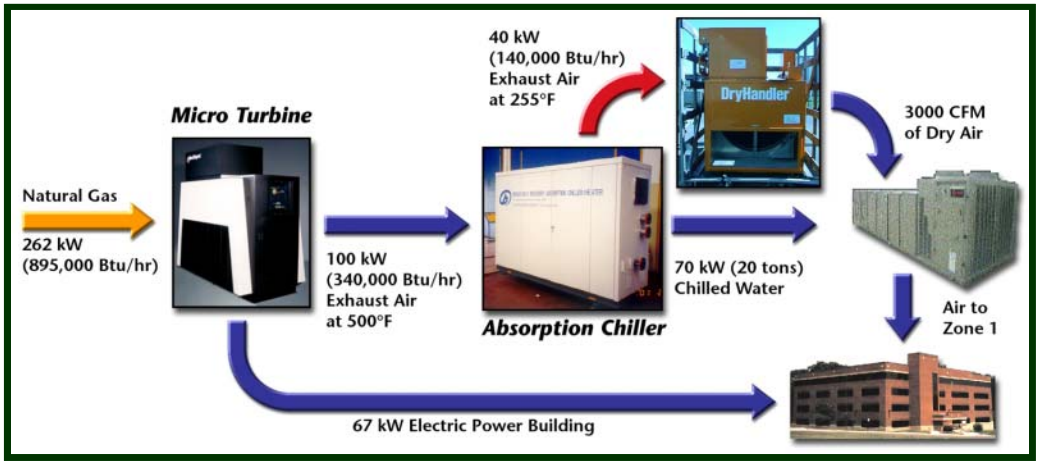
Integration Research & Analysis Tools

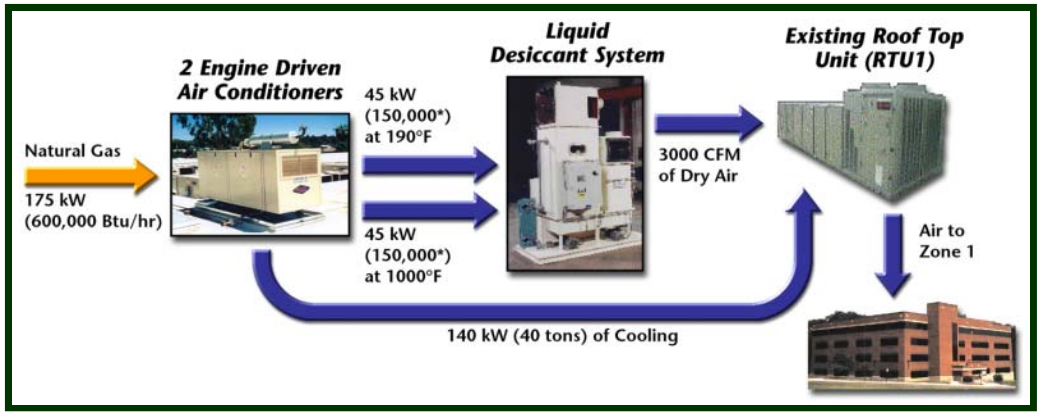
Evaluate electric/thermal parameters, design tools and analysis, IES DG/TAT equipment integration R&D to optimize CHP performance

University Test Center for IES/Building Integration CHP

Integration Research & Analysis Tools

University of Maryland, College Park

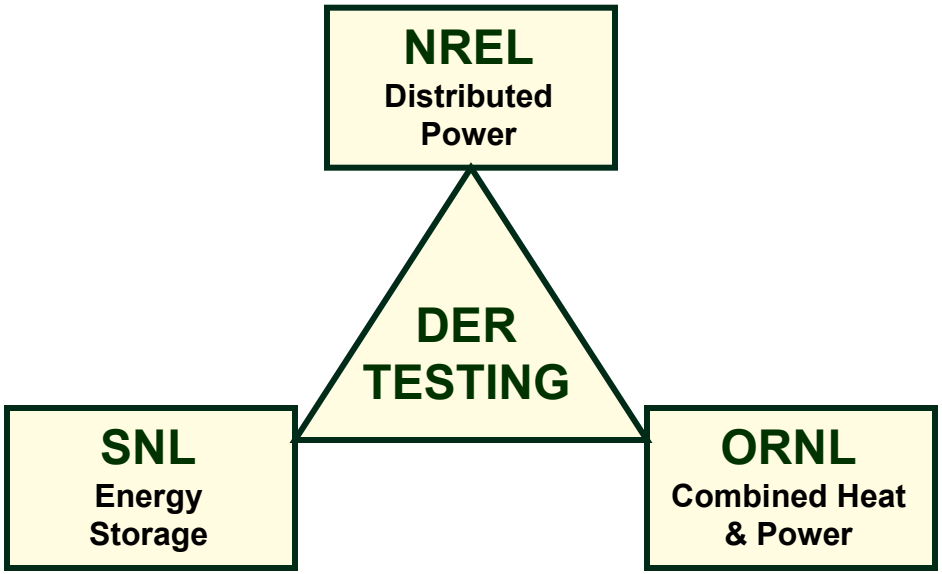




- Integrate IES into building, HVAC System
- Test advanced controls, diagnostics, operating strategies

National Laboratory Coordination for Distributed Energy Resource (DER) Testing is Currently Underway

Integration Research & Analysis Tools



NREL/ORNL

- DG and CHP testing procedures, evaluations and building performance

ORNL/SNL

- Power electronics development and testing

SNL/NREL

- System integration and manufacturer development testing

A Work in Progress

Seven Industry Teams Selected for Awards

IES Packaged and Modular Systems

Large-Scale Modular IES:

- Honeywell Laboratories
- Burns and McDonnell
- Gas Technology Institute

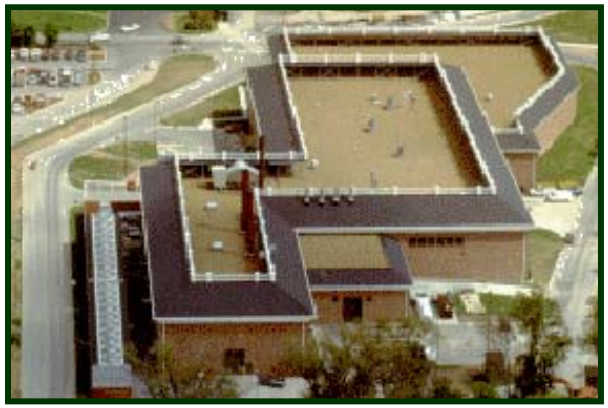
Small-Scale Packaged IES:

- United Technologies Research Center
- Ingersoll Rand
- NiSource Energy Technologies
- Capstone Turbine Corporation

Building on a Strong Foundation

IES Packaged and Modular Systems

- 5 MW gas turbine system with heat recovery, chiller
- 1,000 RT double-effect absorption chiller
- Inlet air cooler uses 300 RT of Chilled water output
- Operating since 1996
- O&M costs reduced from
  - $____ /yr “pre-IES”
  - $____ /yr with IES



OPRYLAND Hotel and Convention Center

Case Study provided by: IC Thomason Associates, Inc., Consulting Engineers, Nashville, TN

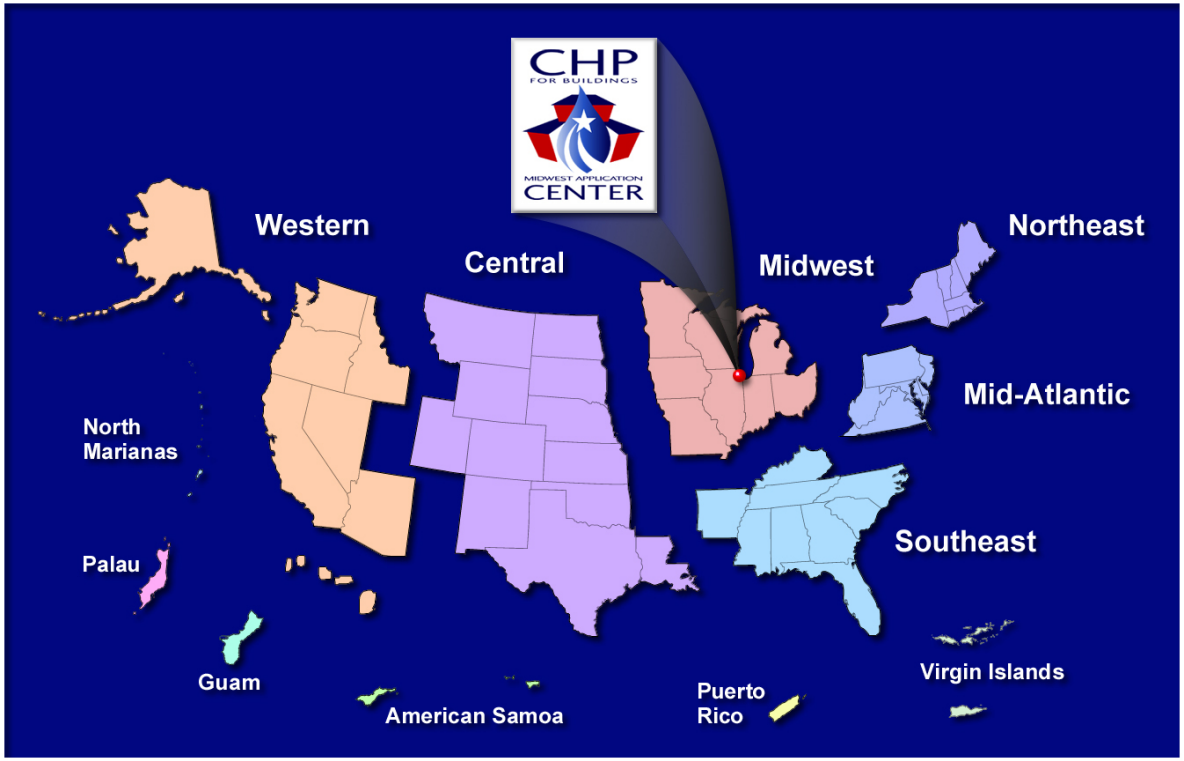
Benefits of Packaged CHP Systems

- Compared to today's custom engineered CHP systems, packaged systems should:
  - Improve performance (efficiency)
  - Increase reliability
  - Reduce first (capital plus installation) cost
  - Reduce maintenance cost
- Packaged Systems will simplify the evaluation, specification, bidding and purchasing of CHP systems.
- This will enable many more architects, engineers, developers, and building owners to easily consider and use these systems.

University of Illinois-Chicago: Midwest Regional CHP Applications Center

Application Centers

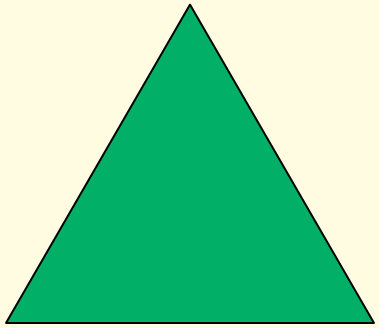
- Facilitate CHP projects, technical assistance
- Region-specific information, application knowledge



The Strategy

An Integrated Approach

Technologies



Policies Markets

RD&D

Public-Private Partnerships

Energy and Environmental Policies

The Ultimate Goal

A competitive marketplace for expanding the use of clean, efficient, reliable, and affordable distributed energy resources

IES-TAT Program Goals

Year 2010:

- To develop the technology, application knowledge, and infrastructure necessary to enable IES to provide - at least 8 GW of on-site electrical power and an additional 10 GW of *useful* thermal energy.
- This effectively contributes a total of 18 GW of affordable efficient energy to the Nation's energy network.

CHPB Web Site
http://www.chpb.net